

**Amendments to the Specification:**

Please replace paragraph [0007] with the following paragraph:

[0007] In the ~~foregoing~~ following, preferred embodiments of the present invention ~~were~~ are explained. However, the present invention is not limited to the embodiments 1-4. As long as the essence of the invention is observed, changes may be made to the design of the present invention.

Please replace paragraph [0027] with the following paragraph:

[0027] The torque sensors 3 form a double system and are arranged between the steering angle sensor 1 and the reaction force motor 5. Each torque sensor 3 has a torsion bar extending in the axial direction, a first shaft connected to one end of the torsion bar and coaxial to the torsion bar, a second shaft connected to the other end of the torsion bar and coaxial to the torsion bar and the first shaft, a first magnetic body fixed to the first shaft, a second magnetic body fixed to the second shaft, a coil facing the first magnetic body and the second magnetic body, and a third magnetic body that surrounds the coil and forms a magnetic circuit together with the first magnetic body and second magnetic body. The coil detects the torque from the output signal on the basis of the inductance that changes corresponding to the relative displacement between the first magnetic body and the second magnetic body ~~on the basis of~~ resulting from the twisting of the torsion bar.

Please replace paragraphs [0031]-[0034] with the following four paragraphs:

[0031] The steering unit includes an encoder 10, a steering angle sensor 11, [[a]] torque sensors 12[[,]] (means for detecting the road surface reaction force), steering motors 14, steering unit 15[[,]] and steered road wheels 16, 16'.

[0032] The steering angle sensor 11 and torque sensors 12 are mounted on pinion shaft 17, on one end of which the pulley of cable column 7 is attached, and on the other end of which a pinion gear is formed. As steering angle sensor 11, an absolute type resolver or the like, which detects the rotational velocity of the shaft 17, can be used. Also, like the torque sensors 3, torque sensors 12[[,]] form a double system that detects torque from changes in inductance. ~~Then, steering~~ Steering angle sensor 11 is set on the side of cable

column 7, and torque sensors 12 are set on the side of steering unit 15. As a result, when the steering angle is detected by steering angle sensor 11, it is unaffected by the change in the angle due to the twisting of torque sensors 12.

[0033] The steering motors 14[[],] have a structure in which a pinion gear engaged to the worm gear set at the central position between steering angle sensor 11 of the pinion shaft 17 and torque sensors 12[[],] is set on the motor shaft[[],]. This is so that a steering torque is applied to pinion shaft 17 when the motor is ON. The steering motors 14[[],] form a double system with a 1 rotor/2 stator structure. They are brushless motors that form first steering motor 14 and second steering motor 14. Also, similar to the reaction force motor 5, due to the adoption of the brushless motors, encoder 10 and a Hall IC (not shown in the figure) is are used.

[0034] The steering unit 15 has a structure in which left/right steered road wheels 16 turn as pinion shaft 17 rotates. It has rack shaft 15b that forms a rack gear engaged with the pinion gear of pinion shaft 17 and is inserted in rack tube 15a, tie rods 15c, 15c' fixed to the two ends of rack shaft 15b extending in the left/right direction of the vehicle, and knuckle arms 15d, 15d' having one end fixed to the tie rods 15c, 15c' and the other end fixed to steered wheels 16, 16'.

Please replace paragraphs [0036] and [0037] with the following two paragraphs:

[0036] The controller 19 receives the detected signals from the following parts: steering angle sensor 1, encoder 2, torque sensors 3, and the Hall IC of the reaction force device, as well as the encoder 10, steering angle sensor 11, torque sensors 12, Hall IC, and a vehicle speed sensor ~~24~~ of the steering device.

[0037] On the basis of the detection values of the various sensors, controller 19 sets the control values of reaction force motor 5 and steering ~~motor~~ motors 14, and controls and drives each of steering motors 14. Also, during ordinary system conditions, controller 19 releases clutch 9. Otherwise, the system engages clutch 9 to establish a mechanical connection between steering wheel 6 and steered wheels 16, 16'.

Please replace paragraph [0040] with the following paragraph:

[0040] In Equation 1, the first, second and third terms on the right-hand side set the control value of the steering reaction force on the basis of steering angle  $\theta$ , and the fourth term on the right-hand side sets the control value on the basis of road surface reaction force  $F$ , so that it can reflect the influence of the force acting from the road surface on the tires to the steering reaction force torque. Also, steering angle acceleration  $d^2\theta/dt^2$  and steering angle velocity  $d\theta/dt$  are computed from the detected value of steering angle sensor 1 (corresponding to the means for detecting the acceleration computing means and the means for detecting the steering angle velocity).

Please replace paragraphs [0043] and [0044] with the following two paragraphs:

[0043] In step S3, because it was determined that the system is not in the hands-off state in step S2, road surface reaction force gain  $K_f$  is set at prescribed High value (corresponding to the steering reaction force correction means), and ~~it~~ processing then returns.

[0044] In step S4, because it was determined that the system is in the hands-off state in step S2, road surface reaction force gain  $K_f$  is set at prescribed Low value smaller than the High value, and ~~it~~ processing then returns.

Please replace paragraph [0049] with the following paragraph:

[0049] Also, in Equation 1, steering angle acceleration gain  $K_{dd}$  for setting the change in the steering reaction force based on steering angle acceleration  $d^2\theta/dt^2$  varies as a function of steering angle acceleration  $d^2\theta/dt^2$ . As shown in Figure 5, steering angle acceleration gain  $K_{dd}$  is set such that it becomes larger when the absolute value of steering angle acceleration  $d^2\theta/dt^2$  becomes larger. Also, steering angle acceleration gain  $K_{dd}$  is set such that it is larger when the vehicle speed is higher.

Please replace paragraph [0053] with the following paragraph:

[0053] However, in the related art, when steering reaction force  $M_m$  is set to an appropriate value for steering, when the hands are released, the steering wheel restoration

force becomes too large, ~~so~~ such that the steering wheel goes past the neutral position and overshoots as shown in FIG. 8.

Please replace paragraph [0055] with the following paragraph:

[0055] Figure ~~9(a)~~ 9A shows the steering reaction force torque with respect to the steering angle in the hands-on state, and Figure ~~9(b)~~ 9B shows the steering reaction force torque with respect to the steering angle in the hands-off state. In the hands-on state, road surface reaction force gain  $K_f$  is set to the High value, so that even if the steering wheel is in return state, the steering reaction force torque can still be transmitted to the driver corresponding to the steering angle.

Please replace paragraph [0057] with the following paragraph:

[0057] ~~Process~~ The process of changing the steering reaction force corresponds to the steering torque. In the first embodiment, in the hands-on state, the steering reaction force torque is larger when the steering torque is larger. Consequently, in switching between the hands-off state and hands-on state,  $D$  is changed smoothly instead of stepwise between the Low value and High value of coefficient  $K_f$ , so that it is possible to realize both a more natural steering wheel recovery performance and a good transmission of the road surface feel.

Please replace paragraphs [0059] and [0060] with the following two paragraphs:

[0059] The system has torque sensors 12 that detect road surface reaction force  $F$ , and reaction force motor 5 applies steering reaction force  $K_f \times F$  corresponding to the road surface reaction force, ~~and when~~. When the hands-off state is detected, the steering reaction force correction means reduces the steering reaction force corresponding to the road surface reaction force with  $K_f$  set at the Low value. Consequently, in the hands-off state, an appropriate steering wheel recovery performance is realized, and, in the hands-on state, the road surface feel can be transmitted accurately to the driver.

[0060] The controller uses torque sensors 3 that detect the steering torque. When the hands-off state is not detected, the steering reaction force correction means reduces the steering reaction force corresponding to the road surface reaction force for a smaller steering

torque. Consequently, in switching between the hands-off and the hands-on state, smooth switching can be realized, and it is possible to realize both a natural steering wheel recovery performance and a good transmission of the road surface feel.

Please replace paragraphs [0064]-[0066] with the following three paragraphs:

[0064] In step S13, because it was determined in step S12 that the system is not in the hands-off state, steering angle gain  $K_p$  is set at the prescribed High value ( corresponding to a steering reaction force correction means), and ~~it~~ processing then returns.

[0065] In step S14, because it was determined in step S12 that the system is in the hands-off state, steering angle gain  $K_p$  is set at the Low value smaller than the High value, and ~~it~~ processing then returns.

[0066] That is, because steering angle gain  $K_p$  is the elastic moment component for returning steering wheel 6 to the neutral point (the neutral position), in the hands-off state~~[[,]]~~ it is set at a smaller value so that there is an appropriate steering wheel restoration to prevent the steering wheel from exceeding the neutral point, that is, so that it does not overshoot; ~~while in.~~ In the hands-on state, ~~it~~ steering angle gain  $K_p$  is set larger to produce an appropriate steering reaction force torque.

Please replace paragraph [0068] with the following paragraph:

[0068] Here, A is the steering angle coefficient set proportional to the absolute value of the steering torque. As shown in Figure 12, A has a prescribed minimum value in the range of the torque sensor value corresponding to the hands-off state, and it has a larger value when the absolute value of the torque sensor value becomes larger. Also, in order to prevent the steering reaction force torque from becoming too large, ~~it~~ the steering angle coefficient A is set so that when the absolute value of the torque sensor value exceeds a prescribed level, ~~it~~ the steering angle coefficient A assumes a prescribed maximum value.

Please replace paragraph [0080] with the following paragraph:

[0080] The controller of the third embodiment has a steering angle acceleration detection means that detects the steering angle acceleration. The reaction force motor 5

applies steering reaction force ~~k<sub>dd</sub>~~ K<sub>dd</sub> x  $d^2t/dt^2$  corresponding to steering angle acceleration  $d^2t/dt^2$ . When the steering reaction force correction means detects the hands-off state, steering reaction force ~~k<sub>dd</sub>~~ K<sub>dd</sub> x  $d^2t/dt^2$  is made smaller corresponding to steering angle acceleration  $d^2t/dt^2$ . As a result, in the hands-off state, the converging frequency of steering wheel 6 becomes higher, and the converging performance can be improved.

Please replace paragraphs [0085]-[0087] with the following three paragraphs:

[0085] Here, B represents the steering angle velocity coefficient set proportional to the absolute value of the steering torque. As shown in Figure 13, steering angle velocity coefficient B is set such that it has a prescribed ~~minimum~~ maximum value in the range of the torque sensor value corresponding to the hands-off state, and it has a ~~larger~~ smaller value when the absolute value of the torque sensor value becomes larger in the hands-on state. Also, in order to prevent the steering reaction force torque from becoming too large, when the absolute value of the torque sensor value exceeds a prescribed level, ~~it~~ the steering angle velocity coefficient B takes on a prescribed ~~maximum~~ minimum value.

[0086] By setting control value  $T_h$  on the basis of Equation 6, steering angle velocity coefficient B is changed smoothly corresponding to the steering torque, and it is possible to realize a more natural steering wheel recovery performance and an appropriate steering torque. Also, ~~in Equation 6, in order to have steering angle  $\theta$  in the reducing direction in the hands-off state, the second term on the right hand side is opposite in sign to the other terms.~~

[0087] For the vehicle steering controller in the fourth embodiment, in addition to ~~effect 1~~ the effects in the first embodiment, the following effects can be realized.